

Alternate cropping system:

A tool to enhance income

L R Meena*, N Subash, Devendra Kumar, Sampat Ram Meena and Adarsh Kumar Meena

ICAR-Indian Institute of Farming Systems Research, Modipuram, Meerut, Uttar Pradesh 250 110

The current cropping systems lack long-term productivity and profitability guarantees. Monocropping adoption brings issues like resource underutilization, low profits, emergence of diseases and pests, and vulnerability to climate change. Soil fertility indicators have been negatively impacted by mono cropping. To improve crop productivity and profitability, adopting alternative cropping systems is crucial. Introducing new crops, advanced production technologies, and diversification strengthens farmers. Efficient cropping systems increase yield, drought resilience, water and nutrient management, pest resistance, biodiversity, and food security. Crop diversification facilitates access to domestic and international markets. It also offers nutritional benefits and promotes self-reliance in food production. Replacing monocropping with high-value crops in diversified systems helps manage market price risks while ensuring sustainable profitability for farmers.

Keywords: Alternate cropping systems, Economics, Prevailing cropping systems, Soil indicator

Agriculture production environment being a dynamic entity has kept evolving continuously. The present phase of changes being encountered by the agricultural sector, such as reducing availability of quality water, nutrient deficiency in soils, climate change, farm energy availability, loss of biodiversity, emergence of new pest and diseases, fragmentation of farm lands and changing consumption pattern coupled with new IPRs and trade regulations regimes are some of the new challenges. The crops and cropping systems with fluctuating behaviour and requirements provide newer challenges as well as opportunity for management to achieve advanced input productivity for water and nutrients. More than 250 double cropping systems are being followed all over the country, amid these 30 cropping systems have been identified for irrigated situations. The prominent systems are considered to be foremost suppliers to the national food basket, viz. rice-wheat (9.85 mha), rice-rice

(5.89 mha) and other coarse grain-based cropping systems like pearl millet-wheat (2.26 mha), maize-wheat (1.86 mha) and pearl millet-mustard (0.94 mha). Out of these systems, the share of rice and wheat together is the highest (65%) to the food grain production, while the rice-wheat system contributes 40% of food grain production. Agronomic

research towards on-farm and off farm with these systems brought out a significant transformation in terms of productivity and profitability along with enhancement of resource use efficiency. Advanced alternate efficient cropping systems have been developed for the replacement of existing cropping systems for significant improvement of the



Cotton varieties ACP-71 suitable for multiple cropping system



Kufri Mohan potato variety suitable for western plain of Uttar Pradesh

wheat (0.97 mha), soybean-wheat (2.23 mha), sorghum-sorghum (0.74 mha), groundnut-wheat, sorghum-groundnut, pearl millet-wheat (1.35 mha), rice-groundnut (1.02 mha), sorghum-wheat, sorghum-gram, pigeon pea-sorghum, groundnut-groundnut, sorghum-rice, groundnut-rice, groundnut-sorghum and soybean-chickpea. But in recent years, new cropping systems have been identified in different agro-climatic zones of the country based on the productivity and profitability.

Selection of cropping systems

Widespread occurrence of circumstances, such as over-mining of soil nutrients, decline in factor productivity, reduction in profitability, lowering of groundwater tables and building up of pests including weeds, diseases and insects has been reported during post-green revolution.

Most of the intensively cultivate, high-productivity, cereal based

productivity. Besides, careful selection of crops and their varieties in the systems, management practices such as tillage, residue management, nutrient, water and weed management plays a vital role in the increased productivity. Hence, income of farmers can be increased manifolds through identification of high income generating alternate cropping systems. The present needs are of identification of alternative/diversified cropping systems which are more dietary and highly remunerated to farmers. Particularly in backward areas where households access to food depends largely on crop productivity rather than other sources of food security. Newly identified cropping systems would be sustained to form a major segment in the farming system which pursued to provide the sustainable livelihood development of a round of 87% households in India.

Predominate cropping systems

Cropping system, an important component of farming systems, represents a cropping pattern used on a farm and their interaction with farm resources, other farm enterprises and available technology, which determine their make-up. In the cropping systems, sometimes a number of crops are grown together or they are grown separately at short intervals in the same field. It has been found that more than 250 double cropping systems are followed throughout the country. Based on rationale of relative spread of crops in each district in the country, 30 important cropping systems have

been identified. These are rice-wheat (10.50 mha), rice-rice (5.58 mha), rice-chickpea (0.59 mha), rice-mustard, rice-groundnut, rice-sorghum, pearl millet-chickpea, pearl millet-mustard (0.94 mha), pearl millet-sorghum (1.35 mha), cotton-wheat (1.39 mha), rice-vegetables (1.24 mha), rice-fallow (4.42 mha) cotton-chickpea, cotton-sorghum, cotton-safflower, cotton-groundnut, maize-wheat (1.29 mha), maize-chickpea (0.54 mha), sugarcane-



Pulse crops (blackgram and chickpea) for alternative cropping systems



Vegetable crops (pea and french bean) for alternative cropping systems



Oilseed (groundnut) and cereal (rice) crops for alternative cropping systems



production systems, which are threatening their studies carried out under AICRP on cropping systems have resulted in identification of appropriate duration of varieties for popular crop sequences for different regions of the country. For considering the specific needs of different regions, concerted efforts have been made to design new alternative cropping systems (Table 1).

Resources for cropping systems in India

Estimates indicate that more than 56% of total food grain comes from irrigated ecosystem while progress has been considerably sluggish in rain fed agriculture which still accounts for 92.8 mha or 65% of net sown area and contributes only 44% to national food grain production. If past trends are any indication,

it may be visualized that in future also the major gain in production, at least 80% of the incremental food need required by 2025, has to come from irrigated ecosystem where new climate resilient crops/cropping systems with climate resilient varieties and intensive nutrients use will continue to play dominant role in enhancing crop productivity. The major crops are having sizeable percentage of area under irrigation in the country; sugarcane (87.9%), wheat (84.3%), barley (60.8%), rapeseed and mustard (57.5%), rice (46.8%), tobacco (41.2%), cotton (33.2%), chickpea (21.9%), maize (21.8%) and groundnut (19.2%). Among the states, Punjab ranks first with 94.6% cropped area under irrigation followed by Haryana (76.4%) and Uttar Pradesh (62.3%). A large diversity of cropping systems exist under

rainfed and dry land areas with an overriding practice of intercropping, due to greater risks involved in cultivating larger area under a particular crop. Due to prevailing socio-economic situations (such as dependency of large population on agriculture, small land holding size, very high population pressure on land resource etc.), improving household food security has been an issue of supreme importance to many farmers of India, which constitute 56.15 mha (<1.0 ha), 17.92 mha (1.0–2.0 ha) and 13.25 mha of semi medium (2.0–4.0 ha) farm holdings, making together 90% of 97.15 million operational holdings. An important consequence of this has been that crop production in India remained to be considered, by and large, a subsistence rather than commercial activity. One of the typical characteristics of

Table 1. Identification of high productive alternative cropping systems

Location	Prevailing cropping systems	System yield (REY t/ha)	Net returns (x10 ³ ₹/ha)	Alternate cropping systems	System yield (REY t/ha)	Net returns (x10 ³ ₹/ha)
Jammu, J&K	Rice-wheat	11.30	226.0	Rice-marigold-french bean	30.10	620.0
Ludhiana (Punjab)	Rice-wheat	13.20	264.0	Rice-potato-onion	29.50	590.0
				Maize-potato-onion	27.9	558.0
				Ground nut-potato-bajra(F)	23.2	466.0
Modipuram (Uttar Pradesh)	Rice-wheat	12.90	258.0	Maize-potato-sunflower	24.2	484.0
				Rice-wheat-moong	15.90	318.0
Sabour (Bihar)	Rice-wheat	11.0	220.0	Rice-potato-onion	29.0	580.0
				Rice-wheat-maize	15.7	314.0
Bhubaneswar (Odisha)	Rice-rice	6.7	134.0	Rice-maize-cowpea	17.4	348.0
				Rice-maize-green gram	14.8	296.0
Coimbatore (Tamil Nadu)	Cotton-sorghum	4.1	82.0	Beet root-green gram-maize+ cowpea	7.1	142.0
				Chillies+onion-sunhemp-okra+coriander	6.6	132.0
Thanjavur (Tamil Nadu)	Rice-rice-sesamum	13.7	274.0	Rice-rice-brinjal	18.3	366.0
				Direct seeded rice-Rice-maize+black gram	17.4	348.0
S.K.Nagar (Gujarat)	Ground nut-wheat-fallow	4.1	82.0	Groundnut-wheat-sesamum	7.0	140.0
				Ground nut-onion-green gram	5.0	100.0
				Maize-groundnut	12.2	244.0
Bangalore (Karnataka)	Hybrid cotton-sunflower	7.0	140.0	Maize-Sun hemp-sunflower	11.3	226.0
Hyderabad (Telangana)	Rice-rice	7.9	158.0	Maize-onion	12.3	246.0
				Maize-tomato	12.1	242.0

REY, Rice equivalent yield. Annual report (2021) of AICRP-IFS, ICAR-IIFSR, Modipuram.



Soybean variety SL 982 suitable for western part of Uttar Pradesh

the sensitivity of these properties to soil management or change in climate, as well as the accessibility and usefulness to producers, scientists, conservationists and policy makers. The selection of indicators implies knowing research needs, and the power to interpret the land use, the relationship between the indicator and the soil function that is being evaluated, the easiness and reliability of the measurement, the variation in time of the crop, application of organic matter or crop rotation in relation to sampling, the sensitivity of the soil property to be measured against changes in the ecosystem. In the same way, for a better interpretation of soil quality indicators, the need of using a baseline for comparison and to determine whether positive or negative impacts on environment have occurred is necessary (Table 2).

farming is that most of the farmers resort to grow a number of crops on their farm holdings, primarily to fulfil their household needs and follow the practice of rotating crop combination over a period of 3–4 years interchangeably on different farm fields.

Soil quality indicators influenced by cropping systems

Agricultural sustainability is related to soil quality assessment and the direction of change of soil quality with time is a primary indicator of whether agriculture is sustainable. Soil quality indicators are a composite set of measurable physical, chemical, and biological attributes which relate to function of soil processes and can be used to evaluate soil quality state, as affected by management. Different management practices are followed under different cropping systems to optimize the biomass/agronomic production per unit area, per unit time and per unit input and the soil attributes that are most sensitive to these managements are most desirable soil quality indicators. Cropping system have significant effects on all soil properties measured especially in the surface soil layer. If the goal is a quality index for crop production, then soil organic matter, infiltration, soil aggregation, pH, microbial biomass, N forms, bulk density, electrical conductivity or salinity, and available nutrients, represent a group of indicators that can be used to describe most

of the soil basic function like the ability to accept, hold and release water to plants, maintain productivity and respond to management and erosion processes. The selection indicators depend on

Table 2. Soil indicators as affected by different cropping systems

Physical indicators	Chemical indicators	Biological indicators
Soil colour	pH	Organic carbon
Oxygen diffusion	Salinity	Oxidizable C and N
Soil tilth	Cation exchange capacity (CEC)	Microbial biomass carbon (MBC)
Soil temperature	Exchangeable sodium percentage (ESP)	Total microbial biomass
Clay mineralogy	Sodium adsorption ratio (SAR)	Microbial community finger printing
Hydraulic conductivity	Electrical conductivity (EC)	Nematodes
Water holding capacity	Organic matter content	Earthworms
Soil aeration	Phosphorus availability	Termites, ants
Infiltration rate	Nutrient cycling	Specific soil fertility
Porosity (pore size, conductivity)	Contaminants such as heavy metals	Fungi, actinomycetes, or lichens
Soil bulk density	Radioactive substances	Soil respiration
Soil depth	Organic compounds	
Aggregate stability		
Soil texture		
Soil compaction		
Soil strength and resistance		
Bio-chemical Indicators	Visual indicators	
Dehydrogenase	Subsoil exposure	
B-glucosidase	Soil erosion	
Phosphatase	Presence of weeds	
Urease	Soil colour	
Arylsulfatase	Type of coverage	
Ergosterol, Glomalin	Comparison between systems operated with the unaided interim anthropogenic	

Source: USDA soil quality indicators.

Economics of new emerging cropping systems

Several, new cropping systems are coming up in the different agro-climatic regions after inclusion of high value crops and their high yielding varieties which are disease resistant in the cropping sequences. These alternative improved cropping systems are proven more and more remunerative than existing cropping systems. The yield potential of alternative cropping systems was high across the different agro-climatic zones of the country due to inclusion of new crops and high yield varieties which are most suitable to those climatic conditions, soil and other production factors. The average yield potential of existing cropping systems ranges between 4.1–13.7 t/ha/year but after adopting alternate cropping, the yield potential can be increased in the tune of 5.0–30.1 t/ha/year. The mean data of different existing cropping systems across the country showed that the yield potential ranges between 9.19 t/ha/year but after adoption of attenuate cropping systems in different locations the yield potential can be increased in the tune of 16.85 t/ha/

year and economic advantage of existing systems stand at ₹183800/ha/year and it can be increased by ₹338000/ha/year. The percentage increase in yield of alternate cropping systems was ₹154200/ha/year after adoption of new crops in place of traditional crops in that area. It is a non-monetary input for crop production, simple farmers have to be aware about the new crops and their varieties which are suitable to their area.

SUMMARY

The current cropping systems in the country do not give the guarantee to be productive and profitable in the future to come. Continuous adoption of mono cropping may lead to issues such as poor utilization of available resources, low monetary gain, emergence of new diseases, pests and insects in the crops and inadequate adaptation to changing climatic conditions. The prevailing mono cropping or single cropping systems has resulted in drastic changes in soil fertility indicators. To achieve better crop productivity and increase profitability, it is necessary to adopt alternate cropping systems that can address aforesaid issues.

Further, introduction of new crops and cropping systems and cutting-edge production technologies can potentially strengthen farmers. Alternate efficient cropping systems can enhance farmers' income by increasing yield, improving drought resilience, increase water and nutrient budgeting through efficient resource management, boosting resistance to pests and diseases and also increase of biodiversity and enhanced nutritional and food security. Crop diversification can enable farmers to gain access to national and international markets with new products. Diversification in existing cropping systems can have important nutritional benefits for farmers in the country and support them in making self-reliant in terms of food production. Addition of high value crops in diversified cropping systems in place of mono cropping can manage price risk to the greater extent in the market. However, at the same time, profitability of the farmers shall sustain itself.

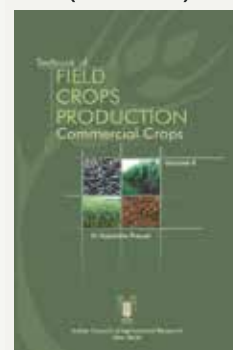
*Corresponding author's e-mail: laxman.meena@icar.gov.in

Textbook of Field Crops Production – Commercial Crops

Availability of high-yielding varieties/hybrids and increased irrigated facilities have resulted in the (Volume II) development of production-intensive cropping systems in several parts of India, and this has catalyzed further agronomic research based on the cropping-system approach. Many changes have also taken place in the crop-production technologies. And this necessitated the revision of the earlier publication brought out in 2002. The revised textbook is in two volumes: First is covering Foodgrains and second is on Commercial Crops.

The discipline of Agronomy has no longer remained mere field trials without application of discoveries emanating from the related disciplines of Genetics, Soil Science and Agricultural Chemistry, Plant Biochemistry, etc. The future Agronomy Landscape will face challenges of climate change, transboundary issues, TRIPS and other trade-related barriers, biotic and abiotic stresses, consequences of biotechnology and genetic engineering and increased market demands in terms of quality assurance, customized food crops, global competition, ecosystem services on land and social equities etc. The Agronomy must measure up to these futuristic challenges with well-defined metrics and methodologies for performance. The advent of hydroponics, precision farming, bio-sensors, fertigation, landscaping, application of ICT, GPS and GIS tools and micro-irrigation is in the horizon. This revised edition in two volumes covers fundamentals of the subject and at the same time will inspire and prepare teachers and students for the emerging frontiers.

(Volume II)



TECHNICAL SPECIFICATIONS

Pages : i-xiv + 612 • Price : ₹ 800 • ISBN No. : 978-81-7164-146-8

For obtaining copies, please contact:

Business Manager

Directorate of Knowledge Management in Agriculture
Krishi Anusandhan Bhavan-I, Pusa, New Delhi 110 012
Tel : 011-25843657, Fax 91-11-25841282; e-mail : bmicar@gmail.com